



Department of Defense (DoD) Technology Readiness Assessment (TRA) Process

Jack Taylor
**Office of the Deputy Assistant Secretary of
Defense for Research**
Ph: (571) 372-6503, jack.taylor@osd.mil



What is a TRA

- **Definition:** A systematic, metrics-based process that assesses the maturity of, and the risk associated with, critical technologies
- **Required** by Statute (10 U.S.C. §2366b) and DoD Regulation (DoD 5000.02 and Guidance Issued May 11, 2011)
- **Purpose:** To assist in the determination of whether the technologies of the program have acceptable levels of risk—based in part on the degree to which they have been demonstrated (including demonstration in a relevant environment)
 - To support risk-mitigation plans prepared by the PM
 - To support certification under 10 U.S.C. §2366b
 - To support technology maturity language for an Acquisition Decision Memorandum (ADM)
- **TRA identified maturity considerations are becoming explicit in Test & Evaluation Strategies (TES) and Test and Evaluation Master Plans (TEMP), e.g. WIN-T,**



10 USCS § 2366b

Certification Required before Milestone B



- **Business case analysis shows**
 - The program is affordable
 - Appropriate trade-offs among cost, schedule, and performance objectives have been made
 - Reasonable cost and schedule estimates have been developed
 - Funding is available
- **On the basis of a PDR, the program demonstrates a high likelihood of accomplishing its intended mission**
- **Market research has been conducted prior to technology development to reduce duplication of existing technology and products**
- **An analysis of alternatives was completed**
- **The technology in the program has been demonstrated in a relevant environment**
- **The program complies with all relevant policies, regulations, and directives**
- **The MDA may waive the certification, if he determines that, but for such a waiver, the Department would be unable to meet critical national security objectives**

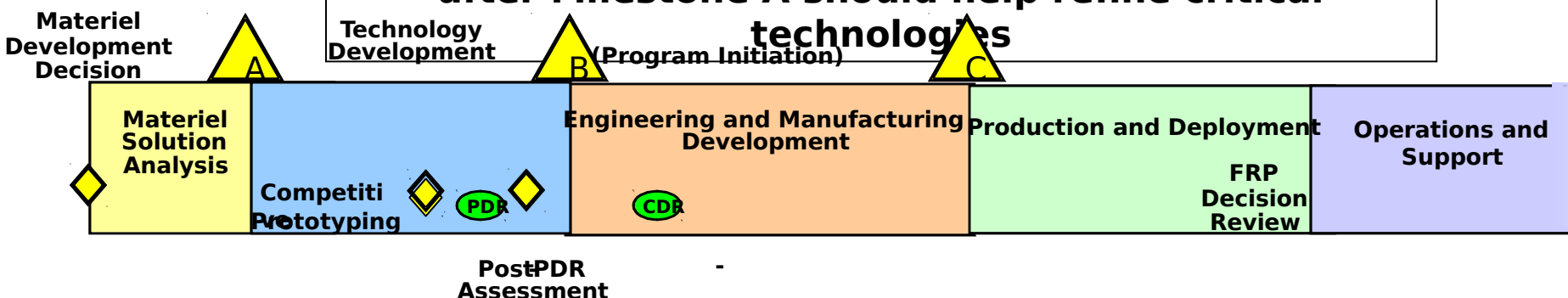


When is a TRA Conducted

- **Milestone B or any other certification decision event**

- Preliminary TRA to be completed prior to the Milestone Decision Authority (MDA) Defense Acquisition Board (DAB) Pre-Milestone B Program Review that precedes Engineering and Manufacturing Development (EMD) Request for Proposal (RFP) release
- Update after Preliminary Design Review (PDR) and prior to Milestone B (Basis for 2366b Certification)

- **When designated by the MDA**
An early evaluation of technology maturity conducted shortly after Milestone A should help refine critical technologies





New TRA Guidance Issued May 11, 2011



ACQUISITION,
TECHNOLOGY
AND LOGISTICS

THE UNDER SECRETARY OF DEFENSE

3010 DEFENSE PENTAGON
WASHINGTON, DC 20301-3010

MAY 11 2011

MEMORANDUM FOR COMPONENT ACQUISITION EXECUTIVES

SUBJECT: Improving Technology Readiness Assessment Effectiveness

As I noted in my "Better Buying Power" memorandum last year, the process for conducting Technology Readiness Assessments (TRAs) has strayed from its original intent and should be reformed. TRAs should focus only on technology maturity, as opposed to engineering and integration risk, and the responsibility for ensuring that technology maturity risk is adequately identified and mitigated should rest with the Program Manager (PM), Program Executive Officer, and Component Acquisition Executive, subject to ASD(R&E) review.

New instructions for conducting TRAs are contained in updated "TRA Guidance" (<http://www.acq.osd.mil/ddre/publications/docs/TRA2011.pdf>). Some of the significant changes from prior TRA procedure are as follows:

- A TRA is required for Major Defense Acquisition Programs (MDAPs) at Milestone (MS) B (or at a subsequent milestone if there is no MS B) to support the independent review and assessment by the Assistant Secretary of Defense for Research and Engineering (ASD(R&E)). The ASD(R&E) will determine whether the technology of the program has been demonstrated in a relevant environment to support the MS Decision Authority (MDA)'s certification under 10 U.S.C. § 2366b. TRAs for the ASD(R&E) are not required for Major Automated Information System programs, non-MDAPs, or MDAP MS C decisions, except for MDAPs entering the acquisition system at MS C. However, MDAs for all programs are required to ensure that technology risk has been reduced to acceptable levels prior to entering engineering development or design for production. Acquisition Category II-IV programs should conduct TRAs in accordance with relevant Component direction by tailoring the "TRA Guidance" as appropriate.
- A TRA will be conducted and reported by the PM who will select a team of subject matter experts to assist in conducting the TRA. The PM will align the process by which critical technologies are identified and evidence of technology maturity is acquired with the program's schedule and resources.
- A preliminary version of the TRA final report will be presented at the pre-MS B MDA Review prior to RFP release for the EMD phase.
- The PM will submit a TRA final report through the appropriate Component Acquisition Executive to the ASD(R&E) who will evaluate the report as part of the basis upon which the ASD(R&E) will make recommendations to the MDA. Based on the advice of the ASD(R&E), the MDA will determine whether to certify technology

maturity, whether the program needs a technology risk mitigation plan, and whether a waiver to 10 U.S.C. § 2366b should be issued.

The new TRA process is effective immediately. MDAPs that have already begun to prepare TRAs using prior guidance should contact the Office of the ASD(R&E) to determine whether they should shift to the new TRA process. The new TRA process will be documented in the "Defense Acquisition Guidebook" (<https://dag.dau.mil>) and institutionalized in the next update to DoDI 5000.02 (<http://www.dtic.mil/whs/directives/corres/pdf/500002p.pdf>). Please share this guidance with the appropriate offices in your organization. My point of contact is Dr. A.M. van Tilborg, OASD(R&E), at 703-695-0598.


Ashton B. Carter PD ACTW6



Improving Milestone Process Effectiveness - Preliminary TRA



PDUSD(AT&L) Memo June 23, 2011

- “Our current milestone review process does not provide adequate opportunity for the MDA to review program plans prior to release of the final RFP, the point at which the Department’s requirements, schedule, planned program content, and available funding should be available for review.
- Program managers shall plan for and MDAs shall conduct a Pre EMD Review before releasing the final RFP for the EMD phase.
- Draft documents include: LFTE Plan, APB, Exit Criteria, SEP, TEMP
- Supporting Documents : CARD, CDD, ICE, DoD Component Cost Estimate, **Preliminary TRA**, STAR



The TRA Process



- **Establish a TRA Plan and schedule**
- **Form a Subject Matter Expert (SME) Team**
- **Identify technologies to be assessed**
- **Collect evidence of maturity**
- **Assess technology maturity**
- **Prepare, coordinate, and submit a TRA report**
- **Review and Evaluation**



SME Team Qualifications



- **Subject matter expertise and independence from the program are the two principal qualifications for SME team membership**
 - Works closely with the PM throughout the TRA process
 - Reviews the performance, technical requirements, and designs being considered for inclusion in the program
 - In conjunction with the PM and ASD(R&E), reviews the PM-provided list of critical technologies to assess and recommends additions or deletions
 - Assesses whether adequate risk reduction to enter EMD (or other contemplated acquisition phase) has been achieved for all technologies under consideration, including, specifically, demonstration in a relevant environment
 - Prepares the SME comments in the TRA report including (1) the SME team credentials and (2) SME team findings, conclusions, and supporting evidence



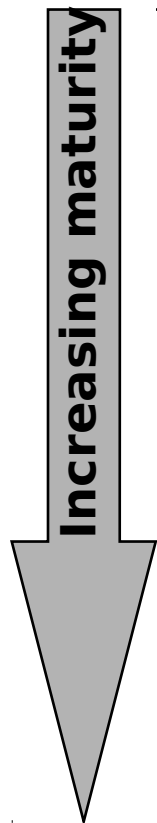
Critical Technologies



- **Critical technologies - those that may pose major technological risk during development, particularly during the Engineering and Manufacturing Development (EMD) phase of acquisition**
- **Identified in the context of a program's systems engineering process, based on a comprehensive view of the most current system performance and technical requirements and design and the program's established technical work breakdown structure**



Technology Readiness Levels



1. **Basic principles observed and reported**
2. **Technology concept and/or application formulated**
3. **Analytical and experimental critical function and/or characteristic proof of concept**
4. **Component and/or breadboard validation in a laboratory environment**
5. **Component and/or breadboard validation in a relevant environment**
6. **System/subsystem model or prototype demonstration in a relevant environment**
7. **System prototype demonstration in an operational environment**
8. **Actual system completed and qualified through test and demonstration**
9. **Actual system proven through successful mission operations**

Technology Readiness Levels (TRLs) can serve as a helpful knowledge-based standard and shorthand for evaluating technology maturity, but they must be supplemented with expert professional judgment



Example: Armor Technologies



- Example**

Armor Development Activity	TRL Level
New design based on measured material properties and knowledge of existing armor performance	TRL 3
Ballistic measurements of armor coupons, environmental and structural testing of armor materials	TRL 4
Demonstration of armor panels at environmental extremes; measure effects of panel size and support	TRL 5
Ballistic Hull and Turret testing of armor design ready for fabrication	TRL 6
Ballistic Testing of production armor installed on full-up prototype vehicle	TRL 7



TRA Report Contents

- **Short description of the program**
- **SME team membership and credentials**
- **List of critical technologies that pose a potential risk to program execution success, with the PM's assessment of the maturity of those technologies as demonstrated in a relevant environment and a description of any risk-mitigation plans**
- **SME team findings, conclusions, supporting evidence, and major dissenting opinions**
- **Cover letter to ASD(R@E) signed by the CAE approving the report, forwarding any requests for waivers of the *10 U.S.C. §2366b* certification requirement with supporting rationale, and providing other technical information deemed pertinent by the CAE and PM**



ASD(R&E) Roles & Responsibilities



- **Reviews the TRA plan provided by the PM and provides comments regarding TRA execution strategy as appropriate**
- **In conjunction with the PM and SME team, reviews the PM-provided list of critical technologies to assess and recommends additions or deletions**
- **Provides the MDA independent recommendations concerning *10 U.S.C. §2366b* certification**
- **If a *10 U.S.C. §2366b* waiver has been requested, provides a recommendation to the MDA, with supporting rationale, as to whether a waiver should be granted**
- **Recommends technology maturity language for an Acquisition Decision Memorandum (ADM), noting, in particular, conditions under which new technology can be inserted into the program**



Summary



- **The DoD TRA Guidance can be downloaded at the ASD(R&E) website at:**

<http://www.acq.osd.mil/chieftechnologist/resources.html>



BACKUP



TRL 5



- **Definition:** Component and/or breadboard validation in a relevant environment.
- **Description:** Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so they can be tested in a simulated environment. Examples include “high-fidelity” laboratory integration of
- **Supporting Information:** Results from testing a laboratory breadboard system are integrated with other supporting elements in a simulated operational environment. How does the “relevant environment” differ from the expected operational environment? How do the test results compare with expectations? What problems, if any, were encountered? Was the breadboard system refined to more nearly match the expected system goals?



TRL 6

Minimum Maturity at Milestone B



- **Definition:** System/subsystem model or prototype demonstration in a relevant environment.
- **Description:** Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in a simulated operational environment.
- **Supporting Information:** Results from laboratory testing of a prototype system that is near the desired configuration in terms of performance, weight, and volume. How did the test environment differ from the operational environment? Who performed the tests? How did the test compare with expectations? What problems, if any, were encountered? What are/were the plans, options, or actions to resolve problems before moving to the next level?



TRL 7

- **Definition:** System prototype demonstration in an operational environment.
- **Description:** Prototype near or at planned operational system. Represents a major step up from TRL 6 by requiring demonstration of an actual system prototype in an operational environment (e.g., in an aircraft, in a vehicle, or in space).
- **Examples include testing the prototype in a test bed aircraft.**
- **Supporting Information:** Results from testing a prototype system in an operational environment. Who performed the tests? How did the test compare with expectations? What problems, if any, were encountered? What are/were the plans, options, or actions to resolve problems before moving to the next level?



Software Technology Readiness Levels from 2005 to 2011



Trends in SW Development Methods, Tools and Techniques



- **Agile Development - 4 values:**
 - Individuals and Interactions over processes and tools
 - Working software over comprehensive documentation
 - Customer collaboration over contract negotiation
 - Responding to change over following a plan
- **Design Patterns**
- **Refactoring**
- **Team Software Process/Personal Software Process**
- **Use of Technology Readiness Levels (TRLs) for software**



Technology Readiness Assessments (TRAs)

Definitions

- **A TRA is a systematic, metrics-based process that assesses the maturity of Critical Technology Elements (CTEs)**
 - A technology element is “critical” if the system being acquired depends on this technology element to meet operational requirements with acceptable development cost and schedule and with acceptable production and operation costs *and* if the technology element or its application is either new or novel
 - Environment is key to “new or novel”
 - May be hardware, software, manufacturing, or life cycle related
 - Uses Technology Readiness Levels (TRLs) as the metric
 - Adequate maturity (TRL 6 or greater) at MS B is largely based on experience with prototypes or previous usage in a relevant environment
- **A TRA is not a risk assessment or a design review**
 - Does not address system integration or imply that the technology is right for the job

The TRA is a regulatory information requirement at MS B and C for all programs!



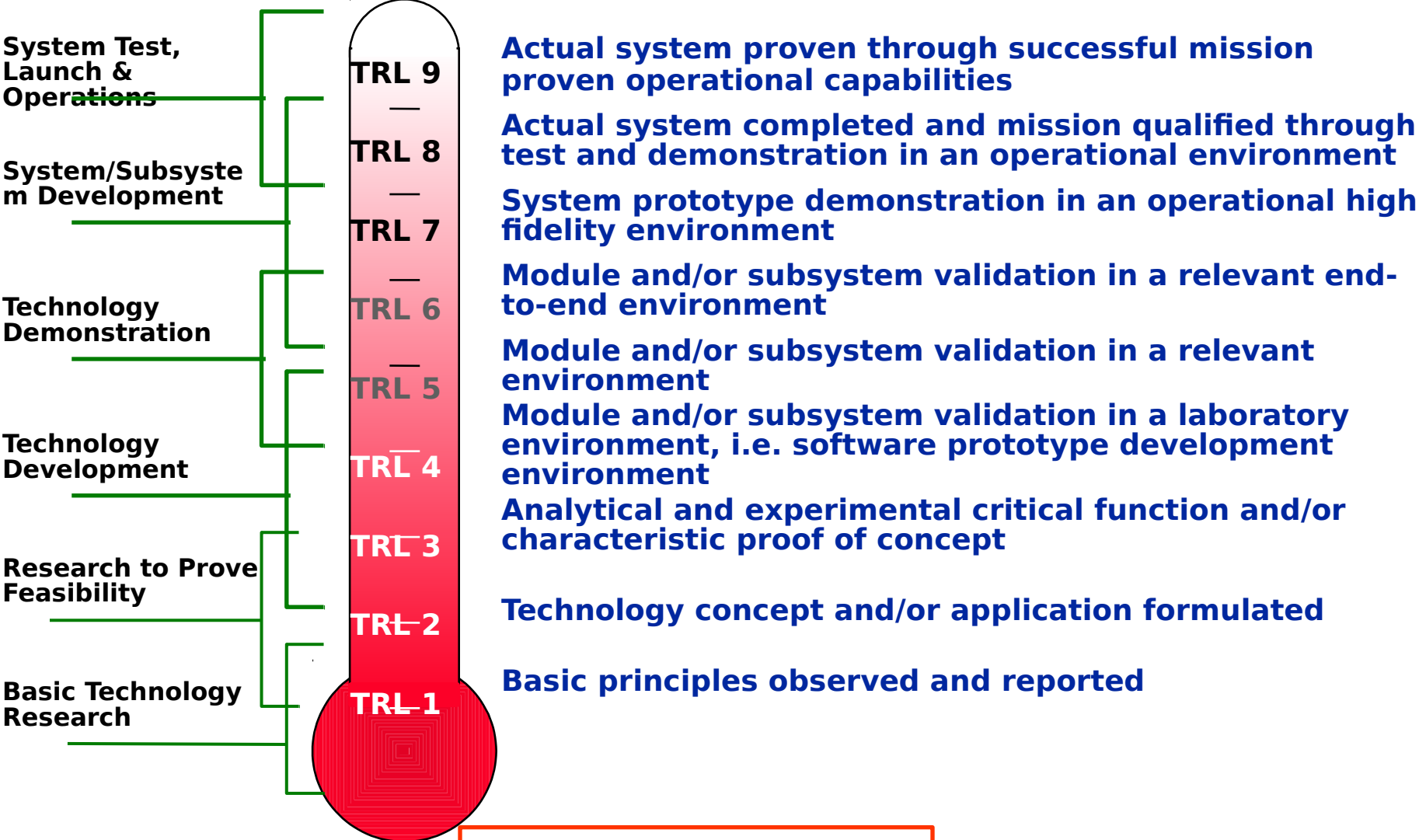
Lessons Learned

Identifying and Assessing Software CTEs

- **CTEs must both impact an operational requirement and be “new or novel”**
 - **CTE is “new or novel” if it is to be used in a different environment, e.g.,**
 - **Physical Environment.** For instance, mechanical components, processors, servers, and electronics; kinetic and kinematic; thermal and heat transfer; electrical and electromagnetic; climatic—weather, temperature, particulate; network infrastructure
 - **Logical Environment.** For instance, software (algorithm) interfaces; security interfaces; Web-enablement
 - **Data Environment.** For instance, data formats and databases; anticipated data rates, data delay and data throughput; data packaging and framing
 - **Security Environment.** For instance, connection to firewalls; security appliques; rates and methods of attack
 - **User and Use Environment.** For instance, scalability; upgradability; user behavior adjustments; user interfaces; organizational change/realignments with system impacts; implementation plan.
- **TRL assignment**
 - **Readiness in relevant environment (TRL 6) requires detailed architecture**
 - **Readiness in an operational environment (TRL 7) requires evidence of acceptable performance under system loading, user interaction, and a realistic communications environment**



Measuring Technology Maturity (Software)





Technology Readiness Assessments *Importance to the Milestone Decision Authority (MDA)*

- **The MDA uses the information to support a decision to initiate a program**
 - Trying to apply immature technologies has led to technical, schedule, and cost problems during systems acquisition
 - TRA established as a control to ensure that critical technologies are mature, based on what has been accomplished
- **According to a GAO review of 54 DoD programs*:**
 - Only 15% of programs began systems development and demonstration with mature technology (TRL 7)
 - Programs that started with mature technologies averaged 9% cost growth and a 7 month schedule delay
 - Programs that did not have mature technologies averaged 41% cost growth and a 13 month schedule delay

Defense Bill, HR 1815, Section 801 requires MDA to certify, prior to Milestone B, that the technology in the program has been demonstrated in a relevant environment (TRL 6)



Technology Readiness Assessments

Value to the Program

- **The PM uses the expertise of the assessment team and the rigor and discipline of the process to allow for:**
 - Early, in depth review of the conceptual product baseline
 - Periodic in-depth reviews of maturation events
 - Highlighting (*and in some cases discover*) critical technologies and other potential technology risk areas that require management attention (and possibly additional resources)
- **The PM, PEO, and CAE use the results of the assessment to:**
 - Optimize the acquisition strategy and thereby increase the probability of a successful outcome
 - Determine capabilities to be developed in the next increment
 - Focus technology investment

For more information: Contact Mr. Jack Taylor
jack.taylor@osd.mil or
see the TRA Guidance at
<http://www.acq.osd.mil/chieftechнологist/resources.html>



TRA Process Overview

